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PREMIUM FOR ENERGY SAVINGS INVESTMENT STUDY.(U)

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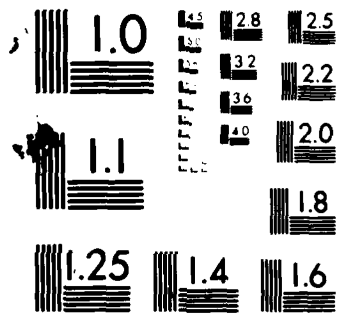

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Premium for Energy Savings Investment Study

by
Ellis E. Kappelman
Propulsion Development Department

MAY 1978

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Naval Weapons Center
CHINA LAKE, CALIFORNIA 93555

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AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

FOREWORD

This report presents the results of work performed during the period July 1976 through April 1977. Support for this work was provided under Work Request 6-137 of 9 January 1976, from the Civil Engineering Laboratory, Naval Construction Battalion Center, Port Hueneme, California.

Dr. Stephen M. Lee has reviewed this report for technical accuracy.

Approved by
P. E. CORDLE, *Head (Acting)*
Ordnance Systems Department
3 May 1978

Under authority of
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(U) *Premium for Energy Savings Investment Study*, by Ellis E. Kappelman. China Lake, Calif., Naval Weapons Center, May 1978, 30 pp. (NWC TP 5960, publication UNCLASSIFIED.)

(U) A study was conducted to determine the premium that should be allowed for energy saving construction at Naval facilities. A number of options or "strategies" were identified that could be pursued in order to establish this premium. The advantages and disadvantages of each were detailed and the preferred strategy was recommended.

CONTENTS

BACKGROUND

It can no longer be assumed that there are sufficient supplies of low-cost energy in the United States to meet projected energy demands during either times of peace or war. The United States Navy consumes a significant quantity of energy either in the form of petroleum fossil fuels or energy derived from them. The availability of this type of fuel is rapidly decreasing and its cost is rapidly rising. If this situation continues, the Navy's strategic posture will be threatened and its ability to respond in times of national emergency will be impaired. Because of the lack of low priced, readily available supplies of energy, and because of its importance, critical decisions regarding future energy for Navy facilities must be made.

The energy supply/demand/cost situation has reached the point where it is necessary for the Navy, as well as the Department of Defense in general, to take steps to decrease its vulnerability. In terms of cost, the Navy has reached the point where it is desirable to determine the premium worth paying in order to save fuel by developing and installing alternatives to conventional uses of petroleum.

Shore facilities represent one of the primary areas of energy consumption in the Navy. For example, estimates of Navy shore facility utility operating costs are:*

1973	$228,000,000
1976	$515,000,000
1979	$723,000,000
1984	$850,000,000

In developing these costs, it was assumed that substantial efforts will be made to conserve energy during future years.

The magnitude of these costs highlights the importance and necessity of developing and implementing energy programs that will insure adequate controls over energy use throughout Navy shore facilities. This will enable each facility to fulfill its assigned mission with a minimum of energy use and waste. To accomplish this task, the Naval Facilities Engineering Command has planned and structured an energy conservation effort to optimize energy savings while maintaining maximum fleet readiness support. The present effort is aimed toward energy savings through repair, rehabilitation, modification, and new construction.

The present effort is a good start and should be continued - perhaps even expanded. It must be recognized, however, that it is only a first step; future programs must entail more than conservation of energy. They must include provisions to make wise investments of funds in facilities that can use new energy forms. It is most

* Data from personal communication with NAVFAC Code 1023 A.

important that these new programs provide Navy shore facilities with the capability to fulfill their missions in times of war or peace.

The choice of future energy types and sources has become both critical and complex. Other factors, besides energy type and sources, which should be considered in selecting future energy supplies include:

1. Interdictable fuel supply lines during wartime
2. Cargo space during peacetime
3. Environmental considerations
4. Political threats
5. Embargoes
6. Cost

A methodology or a strategy to determine the premium in capital expense that the Navy should allow for energy saving, but not cost effective, physical plant investments needs to be developed. It is expected that it will be some time before alternative power systems such as photovoltaics, solar thermal, etc., can be justified on the basis of simple economic analysis. Some guidelines, however, need to be formulated and thinking defined to assist planners in making creditable decisions as to the appropriateness of installing then now.

INTRODUCTION

The objective of this study was to develop a methodology to determine the premium in capital expense that the government should allow for energy saving, but not cost effective, physical plant investments for Naval shore facilities. It was recommended that the study be based upon Department of Defense and Navy economic analysis procedures, except where new directives needed to be devised.

A companion study,[1] being concurrently conducted at NWC was aimed at projecting the costs for fuel oil, natural gas, coal, and electricity to the year 2020. The recommended approach was to combine these energy cost projections with properly modified economic analysis procedures.[2] Hopefully, this would result in a procedure or methodology capable of determining the premium in capital expense properly paid for energy saving plant investment.

PROBLEM DEFINITION

The broad general goal of the Naval Facilities Engineering Command (NAVFAC) is:

> To provide facilities in a cost effective manner such that each Navy shore facility can accomplish its mission in a timely and economical manner.

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[1] Naval Weapons Center, *Fuel Cost Escalation Study*, by Ellis E. Kappelman, et al. China Lake, Calif., NWC, April 1977. (NWC TP 5958, publication UNCLASSIFIED.)

[2] Naval Facilities Engineering Command, *Economic Analysis Handbook*, Washington, D.C., June 1975. (NAVFAC P-442, publication UNCLASSIFIED.)

In the general area of interest for this study it would seem that three potential problems or events could prevent NAVFAC from accomplishing this goal. They are:

1. Nonavailability or limited availability of coal, oil, natural gas, and electricity resulting from embargoes, rationing, etc.
2. Rapid increases, beyond reasonable projections, in prices of coal, oil, natural gas, and electricity.
3. Rapid decrease in energy costs resulting from technical breakthroughs, discovery, etc.

At this point it appeared that not only was it not possible to analytically determine a premium to be paid for energy saving construction, but it was not desirable to do so. It appeared that the objective of this study, as originally stated, would lead to sub-optimization. It, therefore, seemed desirable to restate the objective.

A more appropriate *statement of the objective* of this study was felt to be:

> To develop a strategy for the Navy to use in determining future energy-consuming physical plant investment to insure that Navy shore facilities can accomplish their mission in a timely and cost effective manner.

Modification of existing economic analysis guidelines (such as footnote 2) then becomes one strategy that could be used to accomplish this objective. Stating the problem this way avoids placing anyone or any organization in the awkward and undesirable position of advocating something that is either sub-optimum or that can easily be taken out of context. It also provides for a broader look at the problem .

PROCEDURE

The study started with the gathering and reviewing of appropriate information pertinent to the study. The study sponsors were very helpful in identifying and providing information.

The procedures used within the Navy to evaluate proposed Navy shore facility construction projects had to be reviewed. The Economic Analysis Handbook (see footnote 2) was found to contain the official NAVFAC guidance for preparation of economic analyses in support of the Navy *Shore Facilities Planning System*. It soon became obvious that, if a simple premium to be paid for energy savings investment were to be determined, it would need to be based on this handbook.

A number of primary and secondary economic analysis studies prepared in accordance with the instructions of this handbook were obtained and reviewed. The purpose was to obtain an understanding of the type of response that would normally be prepared. These economic analysis submissions also provided an indication of the level of detail available for their preparation.

Drafts of two submissions by Kling-Lindquist, Inc., prepared by them under NAVFAC contract N00025-74-C-0022, were obtained and reviewed. Both were evidently attempts at accomplishing the objective of this study; however, neither effort was successful.

One suggestion by Kling-Lindquist, Inc. was to arbitrarily select a 25% premium to be paid for energy saving construction. Their other suggestion was to revise the inflation rates for energy given in NAVFAC - INST 11010.55 A. The inflation rates for fuels/energy were to be adjusted in a manner which recognized the strategic nature of these resources and provided a cost advantage to any energy reduction equipment used in a system supplied by a critical fuel. By "tipping" the study slightly in favor of the "low energy" system, it was intended that the life cycle costing comparison could show a cost/benefit ratio of 1.00 or less.

The NWC study next proceeded to develop and detail a number of options or "strategies" that possibly could be used by NAVFAC to determine future energy-consuming physical plant investments. These strategies were then evaluated and compared, and recommendations made as to the "best" or most appropriate strategy.

STRATEGIES

A number of possible strategies, each with its own advantages and disadvantages, were evaluated and are summarized in Table 1. This section details the more important strategies and their advantages and disadvantages are identified. These strategies are generally presented in order of increasing desirability.

STRATEGY NO. 1

Title - Make No Decision

Description. This strategy simply delays making a decision or taking any definitive action to solve the basic problem. This strategy would include studying the problem, talking about it, etc., but actually doing very little except to react to outside influences.

Major Advantages

1. May be the best strategy if no large increase or decrease in energy prices or availability occurs.
2. Least costly in "out-of-pocket" dollars today.
3. Politically safe in the short-term for NAVFAC.

Major Disadvantages

1. Offers no protection in case of rapidly rising energy prices.
2. Offers no protection in case of energy embargoes or rationing.
3. May be very expensive at a later time when some action becomes necessary
4. Not politically safe for NAVFAC in the long term.
5. Does little to promote faster recognition of energy problems.

Discussion. This strategy would probably be pursued by NAVFAC if one or more of the following were true:

1. They perceived that there really was no serious energy problem.
2. They were too timid or unable to decide what to do.
3. They felt that while there was a problem, it wasn't their place to do much about it unless ordered to do so.

It does not appear from past actions that NAVFAC believes any of the above are true. They, therefore, should have no interest in pursuing this strategy.

STRATEGY NO. 2

Title - Initiate Large Construction Program

Description. This strategy would be to immediately try to obtain funds for a large construction program for energy saving buildings and/or buildings utilizing alternate forms of energy. These would then be built as rapidly as Congress could be convinced to make money available.

Major Advantages

1. Good defense against early embargoes, rationing, or rapid fuel cost increases.
2. Reduces present state of high vulnerability to energy shortages and rapid price increases.
3. Good opportunity to upgrade many old and obsolete facilities.

Major Disadvantages

1. Large costs now.
2. May be difficult to convince DOD and Congress that need is urgent enough to justify sufficient funds.
3. NAVFAC would be open to criticism for over-reacting.
4. NAVFAC doesn't really know what needs to be built now.
5. It would be a serious blunder if no serious energy shortage occured or if energy costs were to decrease.

Discussion. The disadvantages are far greater than the advantages. This strategy really is an attempt to solve the prob'em in a brute force manner by additional construction. It surely wo 1 be pref .ble to pursue a program involving some

combination of new construction, load shifting, load shedding, and conservation.

STRATEGY NO. 3

Title - Arbitrary Management Decision

Description. This strategy would consist of making a management decision to build "some" energy saving buildings and/or utilizing alternate energy sources. The amount, location, and type would be arbitrarily selected by management (NAVFAC).

Major Advantages

1. Simple to implement.
2. Plan may be modified rapidly.
3. May be a good strategy if no large increase or decrease in energy prices or availability occurs.
4. Politically safe for NAVFAC.

Major Disadvantages

1. Not simple to correctly choose what and where to build.
2. Difficult to get enough funds for construction of enough building to significantly reduce energy costs.
3. Provides for no comprehensive program combining load shifting, construction, and conservation.
4. Does little to speed recognition of the energy problem.
5. Leaves NAVFAC open to criticism for not having a more definitive program.

Discussion. This strategy could work fine except for the difficulties of deciding where and what to build and getting sufficient funds approved. It is improbable that, without a comprehensive and well publicized program, adequate funds can be obtained.

STRATEGY NO. 4

Title - Biased P-442

Description. This strategy would be to change P-442 in such a manner as to bias or "slant" the results so that construction incorporating energy savings or utilizing alternate energy sources is preferred.

Major Advantages

1. Simple to implement.
2. Strategy may be modified rapidly.
3. Builds on something presently being utilized.
4. Politically safe for NAVFAC in the short term.

Major Disadvantages

1. Takes away from the credibility and acceptance of P-442.

2. Does little to foster recognition of the energy problem.
3. Does not provide for a comprehensive program combining construction with load shifting, load shedding and conservation.
4. NAVFAC open to criticism if no large increase or decrease in energy prices or availability occurs.
5. Does not provide for distribution control.

Discussion. P-442 is generally understood and accepted as fair and appropriate for selecting construction projects. Any modification of P-442 that obviously "slants" or biases the comparison of competing projects will rapidly degrade its credibility. Those proposing construction projects will then tend to regard using the P-442 methodology as just an exercise, and will not try as hard to find a cost effective building alternative. This obviously is not desirable and whether or not the bias is for a good cause probably doesn't matter. It will still be detrimental to P-442 acceptance. The continued use of the 10% discount factor along with the recommended energy escalation rates has in effect already biased P-442 and given an advantage to new energy saving construction.

STRATEGY NO. 5

Title - "Experimental" Facilities

Description. Under this strategy "experimental" facilities such as geothermal plants, breeder reactors, etc. would be constructed within the Navy or Department of Defense (DOD). These would remain "experimental" even though they were capable of providing significant amounts of electricity in times of "need".

Major Advantages

1. May be a good strategy against embargoes, rationing, and rapid fuel cost increases.
2. No criticism expected if energy prices were to decline.

Major Disadvantages

1. Not DOD or Navy responsibility to do energy research of this type or magnitude.
2. Does not solve problem of existing buildings that use energy inefficiently.
3. Very costly.
4. The electricity (or fuel) may not be available to the Navy in time of emergency.
5. Not a very rapid response to the problem.
6. Offers no protection against steadily rising fuel prices.
7. Does little to foster recognition of the energy problem.
8. Does not provide for a comprehensive program combining load shifting, construction, and conservation.

9. May be difficult to fund.
10. Each "experimental" facility will require lots of manpower. Raises management problems. Would require skills not readily available within the Navy.

Discussion. These "experimental" facilities could be capable of producing gasoline as well as electricity. They could be located at remote sites, such as China Lake, and the output shared with other facilities. This sharing could be accomplished by selling electricity to one utility company and then having them sell it to another Navy facility. This would be a brute force type strategy unless companion programs of energy conservation were pursued.

STRATEGY NO. 6

Title - In-House Nuclear Plants

Description. The government (Navy, DOD) would construct one or more nuclear (or coal) electric generating plants to be used exclusively by the Navy or DOD.

Major Advantages

1. May be a good strategy against embargoes, rationing, and rapid fuel cost increases.
2. No criticism expected if energy prices were to decline.

Major Disadvantages

1. Not DOD or Navy responsibility to provide facilities of this type or magnitude.
2. Does not solve problem of existing buildings that use energy inefficiently.
3. Very costly.
4. The electricity may not be available to the Navy in time of emergency.
5. Not a very rapid response to the problem.
6. Does little to foster recognition of the energy problem.
7. Provides for no comprehensive program combining load shifting, construction and conservation.
8. May be difficult to fund.
9. Each facility will require lots of manpower. Raises management problems. Would require skills not readily available in the Navy.

Discussion. This strategy would be quite similar to number 5. The major difference being that, in pursuing number 5. the real purpose of the plants would be somewhat disguised. Here there would be no attempt at deception. The list of disadvantages associated with this strategy is large. It would. however, provide a long term solution if combined with energy conservation. Obtaining sufficient funds would probably be the major problem associated with this strategy.

STRATEGY NO. 7

Title - P-442

Description. This strategy would be to continue to use P-442 as it now exists but without incorporating energy price escalation.

Major Advantages

1. May be the best decision if no large increase or decrease in energy prices or availability occurs.
2. The economic procedures in P-442 seem fair and are generally accepted.
3. Least costly in "out-of-pocket" dollars today.
4. Strategy may be modified rapidly.
5. No criticism expected if energy prices were to decline.

Major Disadvantages

1. Offers little protection in case of rapidly rising energy prices.
2. Offers little protection in case of energy embargoes or rationing.
3. May be very expensive at a later time when some action becomes necessary.
4. Not politacally safe for NAVFAC in the long term.
5. Does little to foster recognition of the energy problem.
6. Does not adequately account for inflation.
7. NAVFAC would be open to criticism for not having a more progressive program.
8. Does not provide for distribution control.
9. Does not take into account the fact that energy prices are rising at a faster rate than the average of other costs.

Discussion. This strategy results in a situation somewhat similar to that of strategy number 1. The primary difference is one of philosophy. To pursue this strategy because it is thought to be proper is quite different than a strategy of procrastination. Pursuing this strategy does not mean that changes cannot be made to P-442 if they seem desirable. It appears that, as a minimum, either an increase in the discount rate or escalated energy prices is proper.

STRATEGY NO. 8

Title - P-442 plus Premium

Description. This strategy would continue to use P-442 as it currently is used, but arbitrarily add a premium that is to be paid for energy conserving construction.

Major Advantages

1. May be a good decision if no large increase or decrease in energy prices or availability occurs.
2. Not costly in "out-of-pocket" dollars today.
3. Strategy may be modified rapidly.
4. Able to justify energy conserving construction now.
5. Easy to implement.

Major Disadvantages

1. Offers little protection in case of rapidly rising energy prices.
2. Offers little protection in case of energy embargoes or rationing.
3. May be very expensive at a later time when some major action becomes necessary.
4. Not politically safe for NAVFAC in the long term.
5. Does little to foster recognition of the energy problem.
6. NAVFAC would be open to criticism for not having a more progressive program.
7. NAVFAC would be open to major criticism if energy prices declined.
8. Difficult to set proper premium.
9. Difficult to defend an arbitrary premium.
10. Does not provide for distribution control.
11. Does not necessarily favor construction that would tend to save the most energy per unit construction cost.

Discussion. This strategy would differ from number 7 in that it would include an arbitrary "premium" to be allowed for energy savings construction. This "premium" would be arbitrary and open to criticism since there is no way of directly calculating it. This strategy is somewhat similar to number 4 in that in both cases P-442 is modified or "biased". This strategy, however, admits to the premium and, therefore, should not be as detrimental to the continued acceptance and use of P-442.

STRATEGY NO. 9

Title - P-442 with "Building Code"

Description. This strategy would be to continue to use P-442 as it now exists but add a "Building Code" type handbook that must be used when estimating costs for new buildings (see Appendix A for a description of "Building Code").

Major Advantages

1. Allows continued use of present economic analysis techniques.
2. No large increase in costs necessary.
3. Good strategy against fairly rapid fuel cost increases.
4. May be a good decision if no large increase or decrease in energy prices or availability occurs.

5. Strategy may be modified rapidly.
6. Simple to implement.
7. Does not detract from the credibility and acceptance of P-442.
8. No major criticism if energy prices were to decline.

Major Disadvantages

1. May invite criticism for "expensive" or "bad" construction practices.
2. Difficult to prepare a "Building Code" for all climates.
3. Offers little short term protection in case of energy embargoes or rationing.
4. Does little to foster recognition of the energy problem.
5. NAVFAC would be open to criticism for not having a more progressive program.
6. Does not solve the problem of existing buildings that use energy inefficiently.
7. Provides for no comprehensive program combining load shifting, construction and conservation.
8. Does not provide for distribution control.
9. Does not take into account the fact that energy prices are rising faster than the average of other costs.

Discussion. This strategy establishes the premium that is to be paid for energy conserving construction by requiring all new buildings to be constructed according to a "Building Code". This "Building Code" would require all new construction to incorporate a number of energy saving features. The "premium" to be paid would then be the difference in costs between conventional construction and that built according to the "Building Code". An obvious important advantage of this strategy is that the results bias new construction in favor of energy savings without detriment to the established economic analysis procedures of P-442.

STRATEGY NO. 10

Title - P-442 with "Building Code" and Energy Prices Escalated.

Description. This strategy would be to continue to use P-442 as it now exists but to use escalated energy prices and to add a "Building Code" type handbook that must be used when estimating costs for new buildings.

Major Advantages

1. Allows continued use of present economic analysis techniques.
2. No large increase in costs necessary.
3. Good strategy against fairly rapid fuel cost increases.
4. May be a good decision if no large increase or decrease in energy prices or availability occurs.
5. Strategy may be modified rapidly.

6. Simple to implement.
7. Does not detract from the credibility and acceptance of P-442.
8. No major criticism if energy prices were to decline.
9. Takes into account the fact that energy prices are rising faster than the average of other costs.

Major Disadvantages

1. May invite criticism for "expensive" or "bad" construction practices.
2. Difficult to prepare a "Building Code" for all climates.
3. Offers little short term protection in case of energy embargoes or rationing.
4. Does little to foster recognition of the energy problem.
5. NAVFAC would be open to criticism for not having a more progressive program.
6. Does not solve the problem of existing buildings that use energy inefficiently.
7. Does not provide for a comprehensive program combining load shifting, construction and conservation.
8. Does not provide for distribution control.

Discussion. This strategy establishes the premium that is to be paid for energy conserving construction by requiring all new buildings to be constructed according with a "Building Code". This "Building Code" would require all new construction to incorporate a number of energy saving features. The "premium" to be paid would. then be the difference in costs between conventional construction and construction in accordance with the "Building Code". An obvious important advantage of this strategy is that the results bias new construction in favor of energy savings without detriment to the established economic analysis procedures of P-442. This strategy also takes into account the fact that energy prices are rising faster than the average of other costs. whereas, strategy number 9 does not.

STRATEGY NO. 11

Title - P-442 with "Building Code", Energy Prices Escalated. and Maximum Energy Savings per Unit Construction Cost.

Description. This strategy would be to continue to use P-442 as it now exists. but escalated energy prices would be used and a "Building Code" type handbook would be added that must be used when estimating costs for new buildings. In addition, preference would be given to those projects that provide maximum energy savings per unit construction cost.

Major Advantages

1. Allows continued use of present economic analysis techniques.
2. No large increase in costs necessary.

3. Good strategy against fairly rapid ruel cost increases.
4. May be a good decision if no large increase or decrease in energy prices or availability occurs.
5. Strategy may be modified rapidly.
6. Simple to implement.
7. Does not detract from the credibility and acceptance of P-442.
8. No major criticism if energy prices were to decline.
9. Allows for the fact that energy prices are rising faster than the average of other costs.
10. Provides for maximum savings per unit construction cost to be obtained.

Major Disadvantages

1. May invite criticism for "expensive" or "bad" construction practices.
2. Difficult to prepare a "Building Code" for all climates.
3. Offers little short term protection in case of energy embargoes or rationing.
4. Does little to foster recognition of the energy problem.
5. NAVFAC would be open to criticism for not having a more progressive program.
6. Does not solve the problem of existing buildings that use energy inefficiently.
7. Does not provide for a comprehensive program combining load shifting, construction and conservation.
8. Does not provide for distribution control.
9. Does not provide for construction of buildings where cost is most sensitive to future energy price rises.

Discussion. This strategy establishes the premium that is to be paid for energy conserving construction by requiring all new buildings be constructed in accordance with a "Building Code". This "Building Code" would require all new construction to incorporate a number of energy saving features. The "premium" to be paid would, then be the difference in cost between conventional construction and construction in accordance with the "Building Code". An obvious and important advantage of this strategy is that the results bias new construction in favor of energy savings without detriment to the established economic analysis procedures of P-442. This strategy is similar to strategy number 10, except number 10 does not necessarily favor construction that would tend to save the most energy per unit construction cost as this one does.

STRATEGY NO. 12

Title - P-442 with "Building Code", Energy Prices Escalated, Maximum Energy Savings per Unit Construction Cost, and Highest Slope.

Description. This strategy would be to continue to use P-442 as it now exists but energy prices would be escalated and a "Building Code" type handbook added that must be used when estimating costs for new buildings. In addition, preference would be given to those projects that provide maximum energy savings per unit construction cost, and to those projects that are most sensitive to energy price escalation rates (see Appendix B for definition).

Major Advantages

1. Allows continued use of present economic analysis techniques.
2. No large increase in costs necessary.
3. Good strategy against fairly rapid fuel cost increases.
4. May be a good decision if no large increase or decrease in energy prices or availability occurs.
5. Strategy may be modified rapidly.
6. Simple to implement.
7. Does not detract from the credibility and acceptance of P-442.
8. No major criticism if energy prices were to decline.
9. Takes into account the fact that energy prices are rising faster than the average of other costs.
10. Provides for maximum savings per unit construction cost to be obtained.
11. Provides for construction of buildings where cost is most sensitive to future energy price increases.

Major Disadvantages

1. May invite criticism for "expensive" or "bad" construction practices.
2. Difficult to prepare a "Building Code" for all climates.
3. Offers little short term protection in case of energy embargoes or rationing.
4. Does little to foster recognition of the energy problem.
5. NAVFAC would be open to criticism for not having a more progressive program.
6. Does not solve the problem of existing buildings that use energy inefficiently.
7. Does not provide a comprehensive program combining load shifting, construction and conservation.
8. Does not provide for distribution control.
9. Choice of new construction won't be optimum if energy prices decrease.

Discussion. This strategy establishes the premium to be paid for energy conserving construction by requiring all new building construction to be in accordance with a "Building Code". This "Building Code" would require all new construction to incorporate a number of energy saving features. The "premium" to be paid would,

then be the difference in cost between conventional construction and construction in accordance with the "Building Code". An obvious important advantage of this strategy is that the results bias new construction in favor of energy savings without detriment to the established economic analysis procedures of P-442. This strategy is similar to that of number 11 except this one tends to favor construction of buildings where cost is most sensitive to future energy price increases.

STRATEGY NO. 13

Title - Energy Conservation Investment Program (ECIP) plus P-442

Description. This strategy would be to continue to use P-442 in conjunction with the ECIP.

Major Advantages

1. May be a good decision if no large increase or decrease in energy prices or availability occurs.
2. Does not adversely affect the economic procedures of P-442.
3. Not costly in "out-of-pocket" dollars today.
4. Strategy may be modified rapidly.
5. No criticism expected if energy prices should decline.
6. Combines aspects of energy saving construction and conservation.

Major Disadvantages

1. Offers inadequate protection in case of rapidly rising energy prices.
2. Offers little protection in case of energy embargoes or rationing.
3. Does not adequately account for inflation.
4. Does not provide for distribution control.
5. Does not take into account the fact that energy prices are rising faster than the average of other costs.
6. NAVFAC may be criticized for not having a more progressive program.
7. Does little to foster recognition of the energy problem.
8. Would not necessarily favor construction that would tend to save the most energy per unit construction cost.

Discussion. This strategy would be somewhat the same as strategy number 8 if the percentage "premium" of number 8 is equal to the percentage of the total construction funds allocated to the ECIP program. This strategy, by combining the ECIP program with P-442, has the advantage of providing for both construction and conservation.

STRATEGY NO. 14

Title - ECIP plus P-442 with Energy Cost Escalation. (status quo)

Description. This strategy would be a continuation of the present program. P-442, with energy prices escalated, would continue to be used and the ECIP program would be continued.

Major Advantages

1. May be a good decision if no large increase or decrease in energy prices or availability occurs.
2. Does not adversely affect the economic procedures of P-442.
3. Not costly in "out-of-pocket" dollars today.
4. Strategy may be modified rapidly.
5. No criticism expected if energy prices were to decline.
6. Combines aspects of energy saving construction and conservation.
7. Allows for the fact that energy prices are rising faster than the average of other costs.

Major Disadvantages

1. Offers inadequate protection in case of rapidly rising energy prices.
2. Offers inadequate protection in case of energy embargoes or rationing.
3. May be very expensive at a later time when some major action becomes necessary.
4. Does little to foster recognition of the energy problem.
5. NAVFAC would be open to criticism for not having a more progressive program.
6. Does not provide for distribution control.
7. Would not necessarily favor construction that would tend to save the most energy per unit construction cost.
8. Does not provide for construction of buildings where cost is most sensitive to future energy price raises.

Discussion. This strategy would be nearly the same as strategy number 8 if the percentage "premium" of number 8 is equal to the percentage of the total construction funds allocated to the ECIP program. The escalated energy prices would be included in conjunction with P-442. By combining the ECIP program with P-442, this strategy has the advantage of providing for both construction and conservation. This strategy is also similar to number 13, except P-442 is modified with escalated energy prices.

STRATEGY NO. 15

Title - ECIP plus P-442 with "Building Code" and Energy Prices Escalated.

Description. This strategy would be to continue the present ECIP program and to use P-442 modified with energy prices escalated. In addition, a "Building Code" type handbook would be prepared and used when estimating costs for new buildings.

Major Advantages

1. May be a good decision if no large increase or decrease in energy prices or availability occurs.
2. Does not adversely affect the economic procedures of P-442.
3. Not costly in "out-of-pocket" dollars today.
4. Strategy may be modified rapidly.
5. No critisim expected if energy prices were to decline.
6. Combines aspects of energy saving construction and conservation.
7. Allows the fact that energy prices are rising faster than the average of other costs to be taken into account.

Major Disadvantages

1. Offers inadequate protection in case of rapidly rising energy prices.
2. Offers little protection in case of energy embargoes or rationing.
3. Does not adequately account for inflation.
4. Does not provide for distribution control.
5. NAVFAC may be criticized for not having a more progressive program.
6. Does little to foster recognition of the energy problem.
7. Would not necessarily favor construction that would tend to save the most energy per unit construction cost.
8. Does not provide for construction of buildings where cost is most sensitive to future energy price increases.

Discussion. Though similar to strategy number 10, this strategy adds the ECIP program to emphasize energy conservation construction. This strategy is also similar to number 14, except the "Building Code" is added. The addition of the "Building Code" along with the ECIP program is somewhat like adding a double premium to the basic P-442.

STRATEGY NO. 16

Title - ECIP plus P-442 with "Building Code", Energy Prices Escalated, and Maximum Energy Savings per Unit Construction Cost.

Description. This strategy would be to continue the present ECIP program and use P-442 modified with energy prices escalated. In addition, a "Building Code" type

handbook would be prepared and used when estimating costs for new buildings, and the energy savings per unit construction cost for each project would be examined. Those projects indicating the greatest savings would tend to be favored.

Major Advantages

1. May be a good decision if no large increase or decrease in energy prices or availability occurs.
2. Does not adversely affect the economic procedures of P-442.
3. Not costly in "out-of-pocket" dollars today.
4. Strategy may be modified rapidly.
5. No criticism expected if energy prices were to decline.
6. Combines aspects of energy saving construction and conservation.
7. Allows for the fact that energy prices are rising faster than the average of other costs.
8. Would tend to favor construction that would save the most energy per unit construction cost.

Major Disadvantages

1. Offers inadequate protection in case of rapidly rising energy prices.
2. Offers little protection in case of energy embargoes or rationing.
3. Does not adequately account for inflation.
4. Does not provide for distribution control.
5. NAVFAC may be criticized for not having a more progressive program.
6. Does little to foster recognition of the energy problem.
7. Does not provide for construction of buildings where cost is most sensitive to future energy price increases.

Discussion. This strategy is the same as number 15, except here those projects providing the greatest energy savings per unit construction cost are favored.

STRATEGY NO. 17

Title - ECIP plus P-442 with "Building Code", Energy Prices Escalated, Maximum Energy Savings per Unit Construction Cost, and Highest Slope.

Description. This strategy would be to continue the present ECIP program and use P-442 modified with energy prices escalated. In addition, a "Building Code" type handbook would be prepared and used when estimating costs for new buildings, and the energy savings per unit construction cost for each project would be examined. Those projects indicating the greatest savings and demonstrating the most sensitivity to energy prices would tend to be favored.

Major Advantages

1. May be a good decision if no sudden large increase or decrease in energy prices or availability occurs.
2. Does not adversely affect the economic procedures of P-442.
3. Not costly in "out-of-pocket" dollars today.
4. Strategy may be modified rapidly.
5. No criticism expected if energy prices were to decline.
6. Combines aspects of energy saving construction and conservation.
7. Allows for the fact that energy prices are rising faster than the average of other costs.
8. Would tend to favor construction that would save the most energy per unit construction cost.
9. Provides for construction of buildings where cost is most sensitive to future energy price increases.

Major Disadvantages

1. Offers inadequate protection in case of rapidly rising energy prices.
2. Offers little protection in case of energy embargoes or rationing.
3. Does not adequately account for inflation.
4. Does not provide for distribution control.
5. NAVFAC may be criticized for not having a more progressive program.
6. Does little to foster recognition of the energy problem.

Discussion. This strategy combines the desirable aspects of each of the previously described strategies with few of their undesirable aspects. It continues the use of P-442 unmodified except for the escalation of energy prices and includes the two discussed "premiums" ("Building Code" and ECIP). It also includes provisions for selecting those projects that promise to save the greatest amount of energy per unit construction cost and which demonstrate the greatest sensitivity to future increases in energy prices. The primary fault of this strategy is its failure to recognize the strategic nature of the problem and to proceed to correct it expeditiously.

STRATEGY NO. 18

Title - Strategic Decision

Description. This strategy would be to recognize the strategic nature of the energy problem (cost and availability) and to take steps to minimize its effect on the ability of Navy Shore Facilities to perform their mission, especially in times of emergency. This strategy would include determining the minimum energy requirements at each facility after considering load shifting, construction, load shedding and

conservation. Steps would then be taken to assure that this energy would be available during times of emergency. These steps would include storage, use of alternate energy sources, in-house coal-fired generating plants, "experimental" facilities, etc. This strategy would include all the aspects of strategy number 17 except the ECIP program.

Major Advantages

1. Provides maximum protection against rationing, embargoes, or rapid energy price increases.
2. May be modified rapidly.
3. Lowest cost in long term.
4. Brings the seriousness of the energy problem to everyone's attention.
5. Provides for distribution control.
6. Is a balanced program combining conservation, construction, load shedding, and load shifting.
7. Provides assurance that each shore facility will have sufficient energy to perform its mission in times of crisis.

Major Disadvantages

1. Costly in "out-of-pocket" dollars today.
2. Would be a bad strategy if the cost of energy were to decrease in the future.

Discussion. This strategy provides good near to intermediate term economic protection against rapid energy price rises. It also insures that each shore facility would not be seriously impeded from performing its mission by energy shortages or embargoes. However, it does not provide protection against decreasing energy prices. This strategy, when combined with strategy number 17, appears to provide both a short and long term program that could be used by NAVFAC to deal with the energy problem in a responsible manner.

These strategies are summarized in Table 1.

TABLE 1. Summary of Strategies.

1. Make No Decision
2. Initiate Large Construction Program
3. Arbitrary Management Decision
4. Biased P-442
5. "Experimental" Facilities
6. In-House Nuclear Facilities
7. P-442
8. P-442 Plus Premium
9. P-442 with "Building Code"
10. P-442 with "Building Code" and Energy Prices Escalated
11. P-442 with "Building Code", Energy Prices Escalated, and Maximum Energy Savings per Unit Construction Cost
12. P-442 with "Building Code", Energy Prices Escalated, Maximum Energy Savings per Unit Construction Cost, and Highest Slope
13. ECIP Plus P-442
14. ECIP Plus P-442 with Energy Cost Escalation
15. ECIP Plus P-442 with "Building Code" and Energy Prices Escalated
16. ECIP Plus P-442 with "Building Code", Energy Prices Escalated and Maximum Energy Savings Per Unit Construction Cost
17. ECIP Plus P-442 with "Building Code", Energy Prices Escalated, Maximum Savings per Unit Construction Cost and Highest Slope
18. Strategic Decision

DISCUSSION

Examining the advantages and disadvantages of the previously described eighteen strategies suggests some general characteristics desirable for any program aimed at solving the Navy's problems of energy availability and cost. These characteristics include:

1. Distribution control
2. Protection against rising energy prices
3. Protection against decreasing energy prices
4. Protection against embargoes and rationing
5. Consideration of load shifting, load shedding, and conservation
6. Consideration of both old and new construction
7. A generally accepted and understood decision process for deciding what, when, and where to build.

It is recognized that it is difficult to provide all of these characteristics in one strategy. Generally speaking, however, as many of them as possible should be included. The best strategy will surely contain most of them.

Many of the strategies discussed have been proposed in the past by various people. These were generally recommended as things the Navy should do to protect one or more individual bases from energy shortages.

Strategy number 17, if continued for a number of years, represents a good procedure to be followed by the Navy. It provides for the gradual introduction of energy saving construction as well as providing for conservation. Several "biases" are contained in this strategy that would tend to offer protection against long term future energy price increases. It offers little protection, however, against sudden large increases or decreases in energy prices or availability.

Although strategy number 17 appears to be an excellent long term procedure, it provides little protection in the short term. Strategy number 18, on the other hand, is primarily directed toward the short term. It provides maximum protection against sudden large increases in energy prices and against rationing or embargoes. It is estimated that this strategy would require 12 - 18 months to implement.

Basic to strategy number 18 is recognizing the strategic nature of the energy problem from the aspects of both cost and availability. Immediate steps are required to minimize the effects of the energy problems on the ability of the Navy shore facilities to perform their missions, especially in times of emergency. This strategy would require a determination of the minimum energy requirements of each Navy shore facility, including considerations of load shifting, load shedding, and conservation. Appropriate steps would then be taken to insure that this amount of energy would be

available during times of emergency. These steps could include storage, "experimental" facilities, etc. It is expected that each major facility would be unique enough to have its own specific requirements and best solutions.

A combination of these two strategies provides for both long and short term protection against energy price escalation and availability. The recommended procedure, therefore, is the adoption of both strategies.

There is one particular difficulty with basing construction of energy saving facilities, or facilities using alternate forms of energy, solely on the economics involved – construction would likely be concentrated at a small number of bases located in the most favorable climates. It would be much more desirable to spread construction around many bases. This would provide some protection against energy price escalation and availability problems at each base, and also provide a method for bringing to the attention of a greater number of people the fact that there really is an energy problem.

There are several approaches for shifting the Navy's energy consumption to alternate fuels that are not included in these strategies. For instance, a determination could be made as to the remaining useful life of Navy shore facilities and a requirement set forth that each year a certain percent of them be replaced or modernized to use alternate fuels.

Another approach would be to require all new construction to include use of alternate energy sources. This requirement would, of course, need to be modified depending on the geographic location of the proposed construction. Requiring the majority of new construction to use alternate energy would shift the majority of our facilities to these alternate types of energy over a period roughly equal to the average useful life of the facilities.

These approaches however tend to be arbitrary and are not readily defensible as good management. They are not recommended.

It does appear desirable for NAVFAC to provide guidance on the state-of-the-art of energy conservation construction and construction using alternate energy sources to those responsible for designing facilities and doing the economic analysis to justify the proposed construction. It does not seem reasonable to expect each shore facility to be knowledgeable to the extent necessary to take advantage of the most recent advances in technology. Rather, NAVFAC should make available several designs of low energy consumption construction or construction using alternate energy sources. Any new information on construction of this type should be widely publicized by NAVFAC so as to encourage others to consider similar construction.

The Economic Analysis Handbook (see footnote 2) appears to be generally understood and considered fair by most users. It appears to be accepted as generally providing a logical method for selecting new construction projects. It would not appear

advisable, therefore, to bias P-442 so as to justify energy saving construction in a manner that would tend to cause it to lose its credibility. However, it would be appropriate and acceptable to escalate future energy prices or incorporate a "Building Code" requirement within P-442. These additions would likely be understood by and acceptable to most users; both represent "premiums" to be paid for energy saving construction.

It would not be appropriate to bias P-442 in such a manner that those using it would feel the "game" is rigged. The users would very likely then tend to be less honest in trying to use it to sell their project. But, both the suggested "Building Code" and the escalated future energy prices can be looked at as representing the premium that is to be paid for energy saving construction. Thus both can be implemented without harming the credibility of P-442.

The cost of implementing and accomplishing a large part of strategy number 18, in a sense, represents a premium to be paid for energy saving construction.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are drawn from the results of this study:

1. P-442 is generally understood and accepted as fair.
2. A biased or slanted P-442 is undesirable.
3. There is no direct way to calculate a "premium" to be allowed for energy savings construction.
4. The selection of a "premium" is a management responsibility and decision.
5. The proper "premium" to be paid is that "premium" necessary to insure that each shore facility can continue to perform its mission in times of energy embargoes.
6. The present ECIP program and the recommended "Building Code" both represent "premiums" for energy saving construction.
7. The cost of implementing strategy number 18 (*the strategic strategy*) also represents a "premium".

Based on the above conclusions, the following recommendations are made:

1. Continue current procedures.
    a. Use P-442 modified with escalated energy prices
    b. Continue ECIP program
2. Add requirement to P-442 to perform calculations to show sensitivity of payback period to:
    a. Energy savings/unit construction cost
    b. Slope
3. Prepare and Use "building code".
4. Rapidly implement strategic strategy.
5. Change the discount rate in P-442 from 10% to 15%.

Appendix A

"BUILDING CODE"

The recommended "Building Code" would be somewhat similar to a conventional city or county building code and used in about the same manner. It would include design requirements to be incorporated in all new construction. Though these design requirements would tend to increase construction costs, they would primarily be aimed at reducing energy consumption. In a sense, the increased cost of construction would be a "premium" to be paid for energy saving construction.

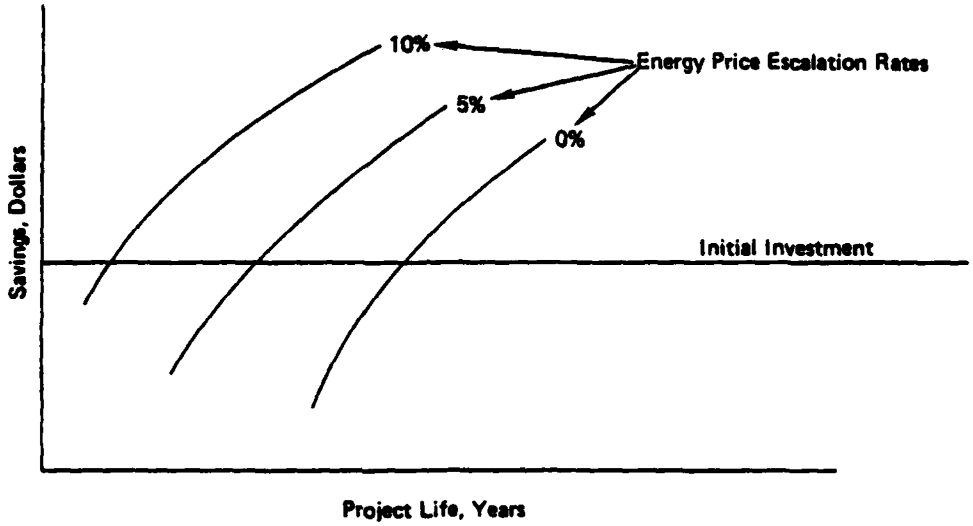
Examples of some of the items that would be included in the "Building Code" would be:

1. The slope of the roof would be optimized so that a solar heater could be added at a later time.
2. The building would be structurally capable of supporting the weight of a solar heater.
3. Provisions to include basements where practical.
4. Requirements for insulation.
5. Air coolers instead of refrigerated systems where practical
6. Berming
7. Short distances from water heaters to place the hot water is used.
8. Landscaping to help protect buildings from wind, sun, etc.

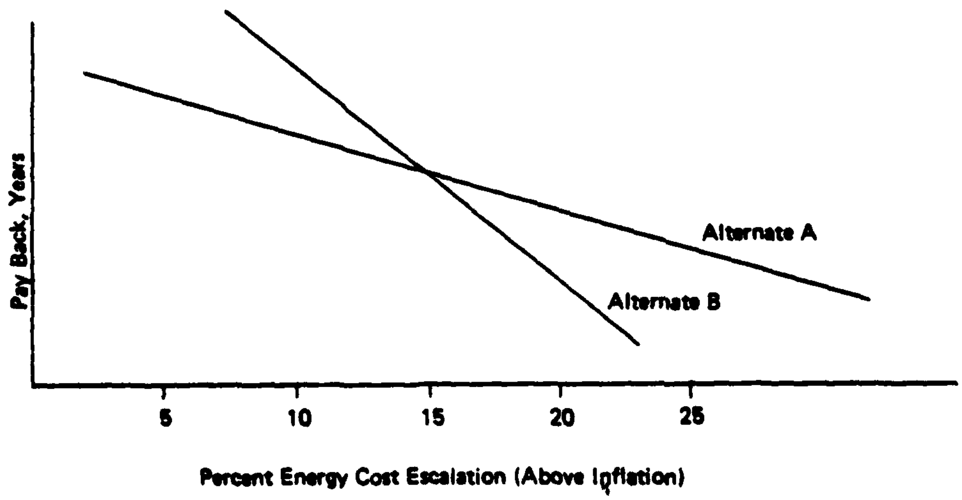
Appendix B

HIGHEST SLOPE

It may be helpful to examine the sensitivity of the payback periods to changes in energy prices when deciding which of two or more proposed construction projects to select. This could be accomplished by calculating the following relationship for all alternatives:



The following relationship could then be made:



In this example the payback period of each alternative is shown to be about the same in the range of probable energy cost escalation rates. The payback period of alternative B, however, is shown to be much more sensitive to the energy cost escalation rate.

When choosing between two or more alternatives having nearly similar payback periods, the one exhibiting the greater sensitivity to energy cost escalation rate should be selected, provided all other considerations are equal. This will provide some protection against higher than expected energy price rises.

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